Gulf and Caribbean Research

Volume 15 | Issue 1

January 2003

Feeding Selectivity of *Anchovia clupeoides* (Pisces: Engraulidae) in the Ciénaga Grande de Santa Marta, Colombian Caribbean

Guillermo Duque
Universidad Nacional de Colombia

Arturo Acero P
Universidad Nacional de Colombia

DOI: 10.18785/gcr.1501.04

Gulf and Caribbean Research Vol. 15, 21–26, 2003 Manuscript received July 24, 2002; accepted March 11, 2003

FEEDING SELECTIVITY OF *ANCHOVIA CLUPEOIDES* (PISCES: ENGRAULIDAE) IN THE CIÉNAGA GRANDE DE SANTA MARTA, COLOMBIAN CARIBBEAN

Guillermo Duque[1*] and Arturo Acero P[2]
[1] *Universidad Nacional de Colombia, A.A. 1016 Invemar, Santa Marta Colombia. *Present address: Department of Oceanography and Coastal Sciences, Coastal Fisheries Institute, Louisiana State University, Baton Rouge, Louisiana 70803 USA, E-mail gduque@lsu.edu*
[2] *Universidad Nacional de Colombia (Instituto de Ciencias Naturales) A.A. 1016 Invemar, Santa Marta Colombia, E-mail aacero@email.arizona.edu*

ABSTRACT Food selection by fishes is an important piece of information for modeling food webs in aquatic ecosystem. Monthly collections were made over a twenty-four hour period between October 1995 and June 1996 to examine the feeding selectivity of the zabaleta anchovy (*Anchovia clupeoides*) in the coastal lagoon Ciénaga Grande de Santa Marta, NE Colombia. A total of 4,389 specimens were collected, and the abundances and weights of the stomach food items were compared with similar measures calculated from samples obtained in nearby habitats. Our results indicate that the zabaleta anchovy is planktophagous, actively selecting copepods and detritus throughout the year. Individuals also exhibit positive selectivity of fish eggs and crab zoea on a seasonal basis and at different times of the day. This species avoids cyanobacteria, diatoms, and rotifers most of the year and during most of the day and always avoids copepod nauplii, polychaete larvae, and cladocerans. It seems that selection and avoidance of the food items by the zabaleta anchovy is due mainly to its preference for prey over 125 μm.

Introduction

Selective feeding by fish means the preference or avoidance of certain available food components (Berg, 1979). To assess selectivity, two factors should be considered when examining food habits of a species: preference for given food types and availability of potential food items. By taking these factors into account one can examine the prey selectivity of a species (Prejs and Colomine 1981). Selectivity is defined as the ratio of the proportion of a given food item ingested to the proportion of that food item in the surrounding habitat. Selectivity depends heavily on the behavior of the predator and prey species (Caddy and Sharp 1988).

Predators may directly impact prey populations, which may in turn influence predator populations (Levinton 1995). Consequently, the alteration of a single predator-prey interaction has the potential to alter the structure of an entire community (Greenstreet and Tasker 1996). Abiotic factors may also play an important role in determining selectivity, since these factors may influence the distribution of potential prey. Periods of targeted feeding important to a population often coincide with a large influx of potential food (Nikolsky 1965).

The engraulid, *Anchovia clupeoides* (Swainson 1839) is an important fish to the pelagic food web in the Ciénaga Grande de Santa Marta (CGSM), Colombia (Duque and Acero 2003). The CGSM estuarine lagoon system is located on the Colombian Caribbean coast, and it is part of the exterior delta of the Magdalena River (Figure 1). To the east, the CGSM is surrounded by the lower hills of the Sierra Nevada de Santa Marta, which reaches an elevation of about 5,800 m above sea level. From this region flow three main rivers that drain into the CGSM. The lagoon is separated from the Caribbean Sea by a barrier island, Isla de Salamanca, and is only connected to the sea by a 200 m wide opening called "Boca de la Barra." To the west and south, the lagoon borders the Magdalena River muddy plains (Wiedemann 1973, Cosel 1986, Botero 1988, Botero and Mancera 1996). The CGSM, with a width of 450 km and a mean depth of 1.5 m (IGAC 1973), has historically been the primary region targeted by local fishermen along the northern coast of Colombia (Santos-Martínez and Acero 1991). Species targeted include shrimp, oyster, crabs, and various fish species (Santos-Martínez and Viloria 1996). The main objective of this research was to determine the feeding selectivity of *A. clupeoides*, a key species in the trophic complex of the pelagic zone in the CGSM.

Methods

Monthly sampling trips were made between October 1995 and June 1996 to the CGSM. During each trip, samples were collected every three hours during a twenty-four hour period, resulting in eight samples per trip. Fishes were collected using a 150 m long and 2 m deep

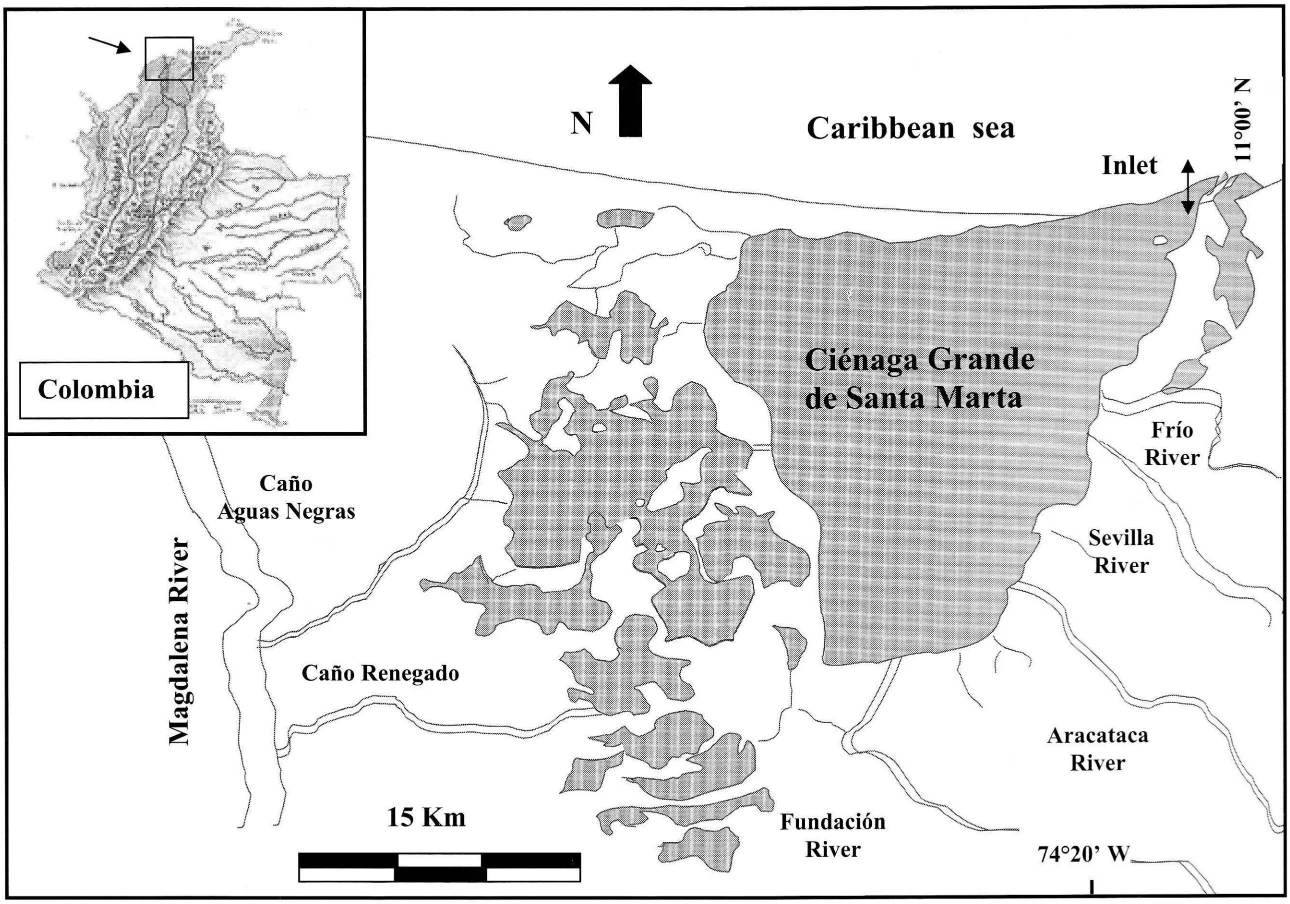

Figure 1. Map of the Ciénaga Grande de Santa Marta, Colombian Caribbean.

nylon monofilament gill net. Mesh sizes were equally distributed between 1.27 cm and 2.54 cm, following the experimental fishing methodology of Rueda and Mancera (1996).

To estimate abundance and biomass of the plankton groups in the fishing area, we collected plankton samples with a suction pump. Eighty liters of seawater were pumped and filtered through 250, 125, and 63 µm sieves. In the laboratory, fish samples were sorted into 5 mm size classes, and the total weight (g) and frequency for each size class was measured. Stomach contents of each individual were removed and passed through 250, 125, and 63 µm sieves. Using a microscope, the stomach contents of *A. clupeoides* and the plankton samples retained on each sieve were identified into large taxonomic groups and the total number of each group was recorded. All stomach and plankton fractions retained by the sieves were dried for 24 hours at 60°C and weighed (g).

The percentage composition by number (Windell and Bowen 1978) of the ingested food by *A. clupeoides* and the potentially available food (plankton samples in the fishing area) was calculated as:

$$\%N = (n/N) * 100;$$

where $\%N$ is the percentage composition by number, n is the number of food items or plankton of a given taxonomic group in a given stomach or water sample, and N equals the total number of food items or plankton in the stomach or water sample.

The selectivity of a given food item was estimated using the logarithmic version of Shorigin's index (Berg, 1979):

$$S = \log_{10} (\%N_1 / \%N_2)$$

where S is the transformed Shorigin selectivity index, $\%N_1$ is the percentage composition by number of the ingested food, and $\%N_2$ is the percentage composition by number of the plankton in the fishing area. If $S > 0$, the item is being actively selected by the fish; if $S < 0$, it is being avoided. Calculations of percentage composition by weight of the ingested food (mg) and the potentially available food (mg/l), and its respective selectivity, were also conducted as above.

RESULTS

Ten planktonic groups were ingested by *A. clupeoides*. The comparison of the percentage composition by number and weight is presented in Figures 2a and 3a. Annual means of Shorigin selectivity index suggest that *A. clupeoides* selected copepods, fish eggs, detritus, and crab zoea (Figure 2b), whereas individuals avoided cyanobacteria, cladocerans, diatoms, copepod nauplii, polychaete larvae, and rotifers.

However, there were some slight differences in selectivity and avoidance of the food ingested by *A. clupeoides* when the annual mean is compared with calculations by month and time of day. Cyanobacteria, diatoms, and rotifers were selected in some of the months of the study, and crab zoea were avoided in October, January, and April (Table 1a). Moreover, the same food items were also selected and avoided at different times of the day (Table 1b).

Results of percentage composition by weight suggest that most of the food ingested by *A. clupeoides* was dominated by individuals larger than 250 µm (Figure 3a), that consisted primarily of copepods. According with the annual mean of Shorigin's index by weight, *A. clupeoides* selected items larger than 125 µm and avoided items between 63 and 125 µm (Figure 3b).

The weight of the food items was recorded only during the last seven months of the study (December to June). Shorigin's index by weight suggests that *A. clupeoides* selected items larger than 250 µm, avoided some items between 125 and 250 µm, and avoided all the items between 63 and 125µm (Table 2).

DISCUSSION

Many physical and biological factors affect the selective behavior of fishes, but the most important are the movement and the size of prey (Leong and O'Connell 1969, O'Connell 1972, Angelescu 1982). Engraulids typically feed either by filtering prey items from water or by actively capturing prey. Choice of prey capture methods is determined by both the density and size of available prey (Leong and O'Connell 1969, O'Connell 1972). The predominant mode of feeding utilized by a species is important in determining the energetic needs and trophic level of the species as a whole (Blaxter and Hunter 1982). It seems that in the CGSM, *A. clupeoides* feeds during the day and night by active predation on preferred prey items, such as copepods and fish eggs. This may be driven by the annual availability of these prey.

The presence of detritus in the stomach of *A. clupeoides* appears to be accidental, and individuals may be unable to sort it from larger prey items due to its small size and high abundance in the CGSM. Leong and O'Connell (1969) suggested that engraulids cannot avoid detritus due to the nature of the filtration mechanisms

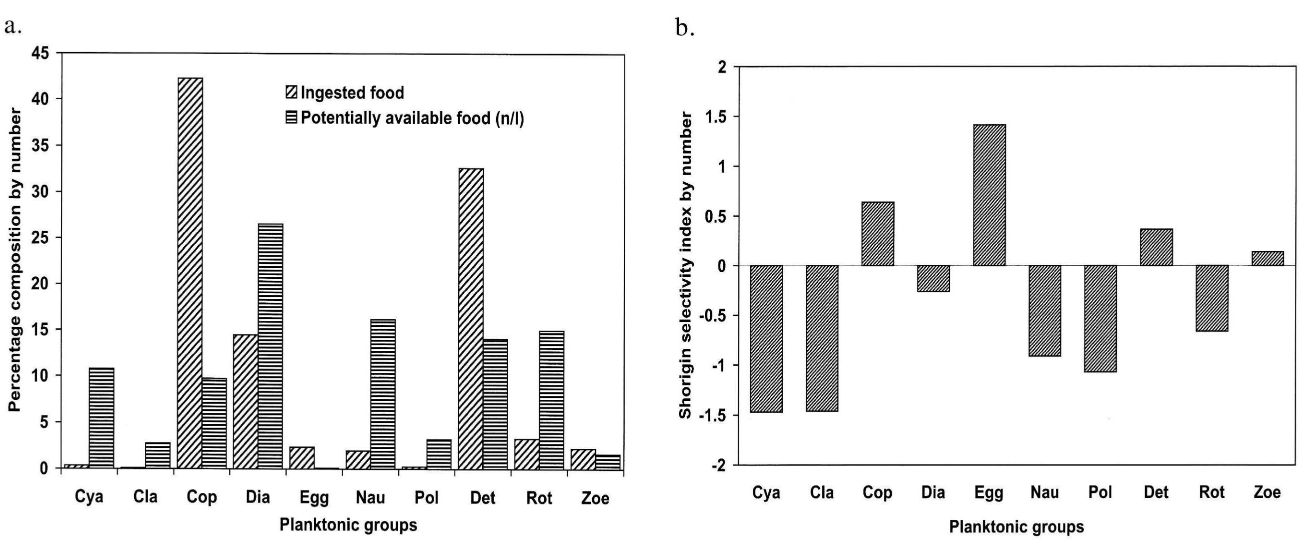

Figure 2. Comparison of the mean percentage composition by number of the food ingested by *Anchovia clupeoides* and the mean percentage composition by number of the potentially available food (a). Mean Shorigin selectivity index by number (b). Abbreviations for taxonomic groups are: copepods (Cop), detritus (Det), diatoms (Dia), rotifers (Rot), fish eggs (Egg), crab zoeas (Zoe), copepod nauplii (Nau), polychaete larvae (Pol), cyanobacteria (Cya), and cladocerans (Cla).

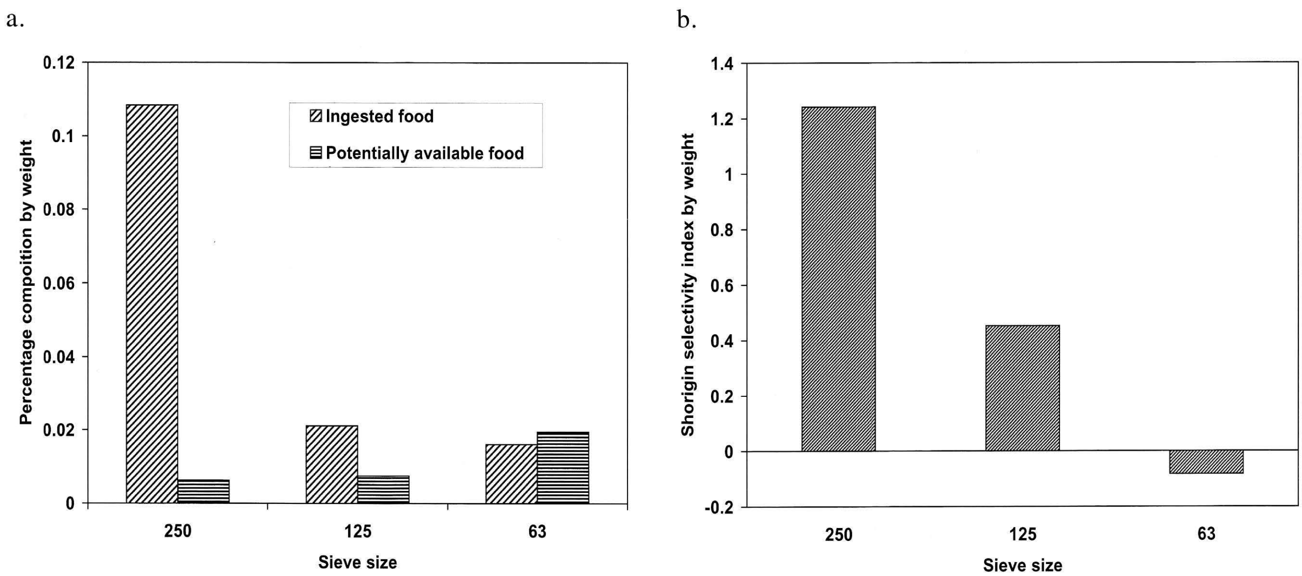

Figure 3. Comparison of the mean percentage composition by weight of the food ingested by *Anchovia clupeoides* and the mean percentage composition by weight of the potentially available food (a). Mean Shorigin selectivity index by weight (b). Sieve sizes in microns.

TABLE 1

Shorigin's feeding selectivity index of *Anchovia clupeoides* by month (a), and time of the day (b). Abbreviations for taxonomic groups are: copepods (Cop), detritus (Det), diatoms (Dia), rotifers (Rot), fish eggs (Egg), crab zoeas (Zoe), copepod nauplii (Nau), polychaete larvae (Pol), cyanobacteria (Cya), and cladocerans (Cla). There are blanks when the specific planktonic group was not found in the fish stomachs at a specific month or time of the day.

a.

Month	Cya	Cla	Cop	Dia	Egg	Nau	Pol	Det	Rot	Zoe
October	1.4		0.7	0.2	1.4		-0.4		-0.7	-0.1
November	1.6	-0.9	0.2	0.3		-2.2	-0.4		-0.6	1.1
December	-1.1		1.0	0.2		-1.0	-0.9		0.0	0.6
January	-1.0	-1.0	0.6	-0.3		-2.4	-0.9	0.3	0.7	-0.6
February	-1.2	-0.7	0.4	-0.2	0.2	-1.3	-0.7	0.3	0.6	0.0
March			0.3	-0.3		-0.7	-1.9	0.5	0.2	0.4
April		-2.7	0.6	-0.6		-1.1	-2.0	0.5	-1.4	-0.4
May			0.5	1.0		-0.5		0.4	-1.0	1.0
June			1.3	-0.5		-0.9		0.2	-0.6	2.0

b.

Time of the day	Cya	Cla	Cop	Dia	Egg	Nau	Pol	Det	Rot	Zoe
09:00	1.1	-0.6	0.9	-0.4	1.0	-0.9	-1.1	0.2	-0.7	-0.4
12:00	-1.3	-1.2	0.5	-0.3		-0.8	-1.4	0.4	-0.8	0.9
15:00	-2.7	-1.3	0.9	-0.1	0.3	-0.7	-0.8	0.3	-0.6	0.7
18:00	-2.4		0.6	-0.2	0.6	-0.9	-1.8	0.2	0.4	-0.3
21:00	-1.3		0.3	-0.2		-1.3	-1.5	0.4	0.5	-0.2
00:00	-1.1		0.4	0.0		-1.2	-0.7	0.5	-0.9	-0.2
03:00	-1.3		0.4	0.1		-0.7	-1.4	0.4	-0.9	0.4
06:00	-1.2	-0.5	1.1	-0.6		-0.7	-1.1	0.4	-0.7	1.5

TABLE 2

Shorigin's feeding selectivity index by weight (mg/l) of *Anchovia clupeoides* at different times of the year and the day. There are data only for the last 7 months of study.

	Sieve size (μm)				Sieve size (μm)		
Month	63	125	250	Time of the day	63	125	250
December	-0.3	0.1	0.2	09:00	-1.2	-0.9	0.6
January	-0.7	0.0	0.8	12:00	-0.9	-0.4	0.7
February	-1.2	-0.5	0.7	15:00	-0.8	-0.3	0.7
March	-0.9	-0.3	0.6	18:00	-0.9	0.0	0.7
April	-1.2	-0.5	0.8	21:00	-0.8	-0.2	0.6
May	-0.7	-0.4	0.6	00:00	-0.6	-0.2	0.6
June	-1.1	-0.4	0.7	03:00	-0.5	-0.1	0.4
				06:00	-0.5	0.0	0.5

involved. Whitfield (1980) reported that fishes are able to digest bacteria and fungi associated with the detritus, suggesting that detritus may enhance the nutritional quality of their diets.

Evidence that engraulids prey directly on primary producers may help to better explain the high productivity of this family in general (Blaxter and Hunter 1989), although *A. clupeoides* is typically thought to be a secondary consumer in the CGSM. On the other hand, Hobson (1968) reported that engraulids are capable of efficient feeding during the night and that the visual acuity of both predator and prey may be largely underestimated. We believe that *A. clupeoides* feeds by active hunting regardless of the season and time of day.

ACKNOWLEDGMENTS

This study was funded by Instituto Colombiano para el Desarrollo de la Ciencia y la Tecnología (COLCIENCIAS) and Universidad Nacional de Colombia grant Procesos reguladores de la producción biológica en lagunas costeras tropicales, CINDEC-Universidad Nacional de Colombia (903189), COLCIENCIAS (CO-1101-09-031-93). We thank Sven Zea, Néstor Campos, Ernesto Mancera, and Beatriz Giraldo for their assistance and collaboration, and Juan Carlos Narváez for providing the study area figure. We also want to thank two anonymous reviewers for their valuable comments in the earlier version of the manuscript. This paper is Contribution 798 of Instituto de Investigaciones Marinas y Costeras (INVEMAR), Colombia, and 217 of Centro de Estudios en Ciencias del Mar (CECIMAR), Facultad de Ciencias, Universidad Nacional de Colombia.

LITERATURE CITED

Angelescu, V. 1982. Ecología trófica de la anchoita del mar argentino (Engraulidae, *Engraulis anchoita*) Parte II. Alimentación, comportamiento y relaciones tróficas en el ecosistema. Contribución INIDEP Mar del Plata 409:1–83.

Berg, J. 1979. Discussion of methods of investigating the food of fishes, with reference to a preliminary study of the prey of *Gobiusculus flavescens* (Gobiidae). Marine Biology 50:263–273.

Blaxter, J.H.S. and J.R. Hunter. 1982. The biology of clupeoid fishes. p. 3–223. In: M. Yonge, ed. Advances in Marine Biology. Academic Press, London, 398 p.

Botero, L. 1988. Caracterización ecológica de la Ciénaga Grande de Santa Marta, una laguna costera tropical en la costa Caribe de Colombia: 1–47. In: L. Botero, ed. Estudio ecológico de la Ciénaga Grande de Santa Marta. Informe final, Proyecto COLCIENCIAS-INVEMAR. CO. 215-09-029-85. Instituto de Investigaciones Marinas de Punta Betín, Santa Marta, 190 p.

Botero, L. and J.E. Mancera. 1996. Síntesis de los cambios de origen antrópico ocuridos en los últimos 40 años en la Ciénaga Grande de Santa Marta (Colombia). Revista de la Academia Colombiana de la Ciencia 20(78):465–474.

Caddy J. E. and G. D. Sharp, 1988. Un marco ecológico para la investigación pesquera. FAO. Documento Técnico de Pesca 283. 155 p.

Cosel, R.V. 1986. Moluscos de la región de la Ciénaga Grande de Santa Marta (Costa de Caribe de Colombia). Anales del Instituto de Investigaciones Marinas de Punta de Betín 15–16:79–370.

Duque, G. and A. Acero. 2003. Food habits of *Anchovia clupeoides* (Pisces:Engraulidae) in the Cienaga Grande de Santa Marta, Colombian Caribbean. Gulf of Mexico Science 21:00–00.

Greenstreet, S.P.R. and M.L. Tasker. 1996. Aquatic predators and their prey. Fishing New Books, Cambrige. 191 p.

Hobson, E.S. 1968. Predatory behavior of some shore fishes in the Gulf of California. US Fish and Wildlife Services Research Report 73, 92 p.

IGAC. 1973. Monografía del Departamento del Magdalena. Instituto Geográfico Agustín Codazzi, Bogotá, 163 p.

Leong, R.J.H. and C.P. O'Connell. 1969. A laboratory study of particulate and filter feeding of the northern anchovy (*Engraulis mordax*). Journal of the Fisheries and Research Board Canada 26:557–582.

Levinton, J.S. 1995. Marine Biology: Function, Biodiversity, Ecology. Oxford University Press, New York, NY, USA. 420 p.

Nikolsky, G.V. 1965. The ecology of Fishes. Academic Press, London, 352 p.

O'Connell, C.P. 1972. The interrelation of biting and filtering in the feeding activity of the northern anchovy (*Engraulis Mordax*). Journal of the Fisheries and Research Board Canada 29:285–293.

Prejs, A. and G. Colomine. 1981. Métodos para el estudio de los alimentos y las relaciones tróficas de los peces. Universidad Central de Venezuela, Caracas, 129 p.

Rueda M.E. and J.E. Mancera. 1995. Alteraciones fisicoquímicas de la columna de agua, generadas por el uso del boliche (método de pesca artesanal) en la Ciénaga Grande de Santa Marta, Caribe colombiano. Anales del Instituto de Investigaciones Marinas de Punta de Betín 24:23–27

Santos-Martínez, A. and A. Acero P. 1991. Fish community of the Ciénaga Grande de Santa Marta (Colombia): Composition and zoogeography. Ichthyological Exploration of Freshwaters 2:247–263.

Santos-Martínez, A. and E. Viloria. 1996. Reportes de la evaluación de la pesquería de la Ciénaga Grande de Santa Marta, Caribe colombiano. Proyecto Invemar—Colciencias—GTZ Prociénaga. Informe proyecto. 70 p.

Whitfield, A.K. 1980. A quantitative study of the trophic relationships within the fish community of the Mhlanga Estuary, South Africa. Estuarine and Coastal Marine Science 10:417–435.

Wiedemann, H.U. 1973. Reconnaissance of the Ciénaga Grande de Santa Marta, Colombia.: Physical parameters and geological history. Mitt. Anales del Instituto de Investigaciones Marinas de Punta de Betín 7:85–119.

Windell, J.T. and S.H. Bowen. 1978. Methods for study of fish diets based on analysis of stomach contents: 219–226. In: T. Bagenal, ed. 1978. Methods for assessment of fish production in fresh water. Blackwell Scientific Publications Ltd., Oxford, U.K., 365 p.